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EXAMINER	
MONBLEAU, DAVIENNE N	

ART UNIT	PAPER NUMBER
2878	

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Please find below and/or attached an Office communication concerning this application or proceeding.

AK

Office Action Summary	Application No.	Applicant(s)	
	09/713,242	SHIELDS ET AL.	
	Examiner	Art Unit	
	Davienne Monbleau	2878	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *20 December 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-4,17-35,56-58 and 60-65* is/are pending in the application.

4a) Of the above claim(s) *35* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-4,17-34,56-58 and 60-65* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *21 May 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *7/3/02*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

The amendment filed 12/20/04 has been entered. Claims 60 and 61 have been amended. Claim 35 is withdrawn from consideration. Claims 1-4, 17-35, 56-58, and 60-65 are pending.

Information Disclosure Statement

The IDS filed on 7/3/02 has been acknowledged and a signed copy of the PTO-1449 is attached herein.

Claim Rejections - 35 USC § 112

Claim31 is rejected under 35 U.S.C. 112, second paragraph, as being incomplete for omitting essential structural cooperative relationships of elements, such omission amounting to a gap between the necessary structural connections. See MPEP § 2172.01. The omitted structural cooperative relationships are: the fiber optic cable and the photo source. The claim recites a fiber optic cable but there is no indication where this cable is located or even if it is connected to the photon source.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-3, 17, 18, and 21 are rejected under 35 U.S.C. 102(b) as being anticipated by Applicant's cited prior art Kim et al. ("A Single-Photon Turnstile Device").

Regarding Claim 1, *Kim* discloses in figure 1 a photon source comprising a quantum dot having a first confined energy level capable of being populated with a first carrier which is an electron and a second confined energy level capable of being populated with a first carrier which is a hole and electrical supply means for supplying carriers to the said energy levels, wherein the supply means are configured to supply a predetermined number of carriers to at least one of the energy levels to allow recombination of a predetermined number of carries in said quantum dot to emit at least one photon.

Regarding Claim 2, *Kim* discloses in Figure 1 repetitively supplying a predetermined number of carriers at a predetermined time to the a t least one energy level to allow emission of a predetermined number of photons at predetermine time intervals.

Regarding Claim 3, *Kim* discloses in Figure 1 repetitively supplying a single carrier to the at least one energy level to allow emission of a single photon separated from each other by predetermined time intervals.

Regarding Claim 17, *Kim* discloses in Figures 1 and 3 electrically injected a predetermined number of carries into the other of said energy levels.

Regarding Claim 18, *Kim* discloses in Figures 1 and 3 that the carriers are injected into the other of said energy levels at the energy of said other energy level.

Regarding Claim 21, *Kim* discloses in Figure 3c a collimating lens for collecting photons.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person

having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 4, 20, and 22-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim in view of Sugiyama et al. (U.S. 6,177,684).

Regarding Claim 4, *Kim* does not teach a plurality of quantum dots. *Sugiyama '684* teaches in the abstract a photon source comprising a plurality of quantum dots. It would have been obvious to use a plurality of quantum dots in *Kim*, as taught by *Sugiyama '684*, to store information. (See *Sugiyama '684* column 1 lines 13-16.)

Regarding Claim 22, *Kim* does not teach a mirror cavity. *Sugiyama '684* teaches in figure 7 and in column 10 lines 34-43 a mirror cavity having a mirror (M and AR) located on opposing sides of a quantum dot (26b). It would have been obvious to one of ordinary skill in the art at the time of the invention to use a mirror cavity in *Kim*, as taught by *Sugiyama '684*, to form an optical cavity of a laser diode which can produce an amplified optical beam.

Regarding Claims 20 and 23, *Kim* does not teach an anti-reflection coating located on the output surface. *Sugiyama '684* teaches an output surface (the right side of the device) and said mirror closest to said output surface is partially reflective (AR coating). It would have been

obvious to one of ordinary skill in the art to use an anti-reflective coating in *Kim*, as taught by *Sugiyama '684*, to prevent external/unwanted light from entering the device and altering the output beam.

Regarding Claim 24, *Kim* in view of *Sugiyama '684* does not teach the energy of the cavity mode. However, it is well known in the art that the energy of the cavity mode is substantially equal to the optical output beam because the energy of the cavity mode determines in effect the energy of the output beam.

Regarding Claim 25, *Kim* in view of *Sugiyama '684* does not teach the cavity length. However, it would have been obvious to one of ordinary skill in the art at the time of the invention to choose a specific distance between the two mirrors to achieve a desired cavity length since it is well known in the art that the length of a cavity directly affects the output wavelength of the optical beam. Furthermore, it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Regarding Claim 26, *Kim* in view of *Sugiyama '684* does not teach the spectral band-pass of the cavity. However, it would have been obvious to one of ordinary skill in the art at the time of the invention to use a specific spectral band-pass of the cavity since it is well known in the art that the spectral band-pass directly determines the spectral width of the radiation that is emitted from the dot. Furthermore, it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Regarding Claim 27, *Kim* in view of *Sugiyama '684* does not teach the position of the quantum dot. However, it would have been obvious to one of ordinary skill in the art at the time of the invention to place the quantum dot at a specific location within the standing wave pattern of the mirrors to provide the maximum gain from the quantum dot. Furthermore, it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In re Boesch, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

Claims 19, 30, and 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim in view of Crow (US 5,423,798).

Regarding Claim 19, *Kim* teaches Figure 1c coupling means (lens) to focus said photons that are emitted through a surface onto a counting detector, but does not teach a fiber optic. *Crow* teaches in Figure 4 the output of a light source (the light transmitted through element 36) coupled to a fiber optic cable (42). It would have been obvious to one of ordinary skill in the art at the time of the invention to couple the output into a fiber optic cable in *Kim*, as taught by *Crow*, to efficiently couple the photon to the counting detector and minimize energy loss.

Regarding Claim 30, *Kim* does not teach a fiber optic cable. *Crow* teaches in Figure 4 the output of a light source (the light transmitted through element 36) coupled to a fiber optic cable (42). It would have been obvious to one of ordinary skill in the art at the time of the invention to couple the output into a fiber optic cable in *Kim*, as taught by *Crow*, to efficiently couple the photon to the counting detector and minimize energy loss.

Regarding Claim 32, *Kim* in view of *Crow* does not teach an anti-reflection coating. It would have been obvious to one of ordinary skill in the art at the time of the invention to have a

non-reflective coating on the fiber in order to maintain the desired output wavelength of the light source.

Claims 28 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim in view of Sugiyama '684, as applied to Claim 22 above, and in further view of Cho et al. (US 5,314,838).

Regarding Claim 28, *Kim* in view of *Sugiyama '684* does not teach a Bragg mirror. *Cho* teaches in Figure 1 laser comprising a mirror cavity with a Bragg mirror (70) with alternating layers. It would have been obvious to one of ordinary skill in the art at the time of the invention to use a Bragg mirror in *Kim*, as taught by *Cho*, to create an efficient resonant cavity with minimum loss.

Regarding Claim 29, *Kim* in view of *Sugiyama '684* does not teach a mirror comprising a metal layer and a phase matching layer. *Cho* teaches in column 2 lines 1-7 and in Figure 3 that a mirror may comprise a metal layer and a phase matching layer (80). It would have been obvious to one of ordinary skill in the art at the time of the invention to use a metal layer and a phase matching layer in *Kim*, as taught by *Cho*, to enhance the reflectivity of a metalized reflective surface and to enhance the constructive interference between reflected light, respectively.

Claim 31, to the extent taught and understood, is rejected under 35 U.S.C. 103(a) as being unpatentable over Kim in view of Sugiyama '684 and Cho, as applied to Claim 29 above, and in further view of Crow.

Regarding Claim 31, *Kim* teaches a photon source but does not teach a fiber optic cable. *Crow* teaches in Figure 4 the output of a light source (the light transmitted through element 36) coupled to a fiber optic cable (42). It would have been obvious to one of ordinary skill in the art

at the time of the invention to use couple the output into a fiber optic cable in *Kim*, as taught by *Crow*, to use the source in a communications system. Furthermore, it would have been obvious to one of ordinary skill in the art at the time of the invention to have the wavelength of the fiber equal to that of the cavity mode in order to maintain the output wavelength of the light source.

Claim 33 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kim in view of Sobolewski et al. (U.S. 6,812,464).

Regarding Claim 33, *Kim* teaches a photon source but does not teach a filter. *Sobolewski* teaches in Figure 4A a single photon detection device comprising a light source (11) and filters (63) to select emitted photons of a particular energy. It would have been obvious to one of ordinary skill in the art at the time of the invention to use filters in *Kim*, as taught by *Sobolewski*, to provide a photon source suitable for applications including free-space and satellite communications, quantum communications, quantum cryptography, weak luminescence, and semiconductor device testing. (See *Sobolewski* abstract.)

Claims 34 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kim.

Regarding Claim 34, *Kim* teaches a photon source but does not teach a polarizer. However, it would have been obvious to one of ordinary skill in the art at the time of the invention to use a polarizer in *Kim* to permit photons of a certain polarization to be detected. This may be particularly useful in communication devices such as quantum cryptography.

Claim 56 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kim in view of Sugiyama (US 6,281,519).

Regarding Claim 56, Kim teaches a photon source with a quantum dot but does not teach that the quantum dot is encapsulated between two adjacent layers having different lattice

constants than the quantum dot. *Sugiyama '519* teaches in Figure 8 and in column 10 lines 35-46 a semiconductor device comprising a quantum dot (15) encapsulated between two adjacent layers (14 and 16) that have different lattice constants from said quantum dot (15). It would have been obvious to one of ordinary skill in the art at the time of the invention to encapsulate the quantum dot in *Kim*, as taught by *Sugiyama '519*, to have spontaneous alignment in the direction generally perpendicular to the principal surface of the substrate. (See *Sugiyama '519* column 10 lines 29-34.) Additionally, from a manufacturing standpoint, it is easier to form quantum dots on lattice layers with different lattice constants.

Claims 57, 58, and 60-63 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sugiyama '684 in view of Molotkov ("Quantum Cryptography ... ").

Regarding Claim 57, *Sugiyama '684* teaches in Figure 1 a photon source comprising a quantum dot (3b) having a first confined energy level capable of being populated with a first carrier which is an electron and a second confined energy level capable of being populated with a second carrier which is a hole, wherein said quantum dot (3b) is encapsulated between two layers having different lattice constants than the quantum dot (column 3 lines 46-57). Although *Sugiyama '684* does not teach supply means in Figure 1, it is inherent that said device comprises supply means for supplying carriers to the energy levels and that the supply means are configured to supply a predetermined number of carriers to at least one of the energy levels to allow recombination of a predetermined number of carries in said quantum dot to emit at least one photon. Without supply means, the device would not operate. *Sugiyama '684* further teaches in Figure 7 that mirrors may be placed on mutually opposing edge surfaces of said photon source to resonantly excite a predetermined number of carriers. *Sugiyama '684* does not

teach that said supply means comprises a source of pulsed incident radiation. *Molotkov* teaches in Figure 1a a photon source with a source of pulsed incident radiation. It would have been obvious to one of ordinary skill in the art at the time of the invention to use pulsed incident radiation in *Sugiyama '684*, as taught by *Molotkov*, to allow reliable separation of the spontaneous radiation of single photons. (See *Molotkov* page 689 first paragraph.)

Regarding Claim 58, *Molotkov* teaches in Figure 1a that said supply means comprises incident radiation configured to excite a predetermined number of electrons and/or holes into the first and second energy levels respectively.

Regarding Claims 60-62, *Molotkov* teaches on page 688, 4th paragraph to page 689, 1st paragraph determining the optimum pulse duration to avoid uncontrolled emission of several photons. It would have been obvious s to one of ordinary skill in the art at the time of the invention to use a particular pulse duration, with respect to the relaxation time of a carrier and the recombination time of an electron and hole within a quantum dot, to ensure the separation of the stimulated photon emission.

Claim 63 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sugiyama '684 in view of Molotkov and Kim.

Regarding Claim 63, *Sugiyama '684* teaches in Figure 1 a photon source comprising a quantum dot (3b) having a first confined energy level capable of being populated with a first carrier which is an electron and a second confined energy level capable of being populated with a second carrier which is a hole, wherein said quantum dot (3b) is encapsulated between two layers having different lattice constants than the quantum dot (column 3 lines 46-57). Although *Sugiyama '684* does not teach supply means in Figure 1, it is inherent that said device comprises

supply means for supplying carriers to the energy levels and that the supply means are configured to supply a predetermined number of carriers to at least one of the energy levels to allow recombination of a predetermined number of carries in said quantum dot to emit at least one photon. Without supply means, the device would not operate. *Sugiyama '684* does not teach that said supply means comprises a source of incident radiation. *Molotkov* teaches in Figure 1a a photon source with a source of incident radiation. It would have been obvious to one of ordinary skill in the art at the time of the invention to use incident radiation in *Sugiyama '684*, as taught by *Molotkov*, to allow reliable separation of the spontaneous radiation of single photons. (See *Molotkov* page 689 1st paragraph.) *Sugiyama '684* also does not teach modulations means. Kim teaches on page 502 modulation means for varying transition energies of the quantum dot. It would have been obvious to one of ordinary skill in the art at the time of the invention to use modulation means in *Sugiyama '684*, as taught by *Kim*, to adjust the number of electrons and holes that are injected during a modulation period, and hence the number of emitted photons. (See *Kim* page 502 2nd column.)

Claim 64 is rejected under 35 U.S.C. 103(a) as being unpatentable over Stintz (U.S. 6,816,525) in view of Sobolewski.

Regarding Claim 64, *Stintz* teaches in Figures 4C and 20B a photon source comprising a plurality of quantum dots (406) having first confined energy levels capable of being populated with first carriers which are electrons and second confined energy levels capable of being populated with second carriers which are holes, the quantum dots having a distribution of transition energies such that a level of the first confined energy levels and/or the second confined energy levels differs among the quantum dots (column 18 lines 15-30), and supply means

(column 18 lines 41-49) for supplying carriers to the energy levels, wherein the supply means supplies carries to at least one of the first and second confined energy levels to allow recombination of carriers in said quantum dots (406) to emit at least one photon. Stintz *does not teach a filter. Sobolewski* teaches in Figure 4A a single photon detection device comprising a light source (11) and filters (63) to select emitted photons of a particular energy. It would have been obvious to one of ordinary skill in the art at the time of the invention to use a filter in *Stintz*, as taught by *Sobolewski*, to provide a photon source suitable for applications including free-space and satellite communications, quantum communications, quantum cryptography, weak luminescence, and semiconductor device testing. (See *Sobolewski* abstract.)

Claim 65 is rejected under 35 U.S.C. 103(a) as being unpatentable over Stintz (U.S. 6,816,525) in view of Santori (U.S. 6,728,281).

Regarding Claim 65, *Stintz* teaches in Figures 4C and 20B a photon source comprising a plurality of quantum dots (406) having first confined energy levels capable of being populated with first carriers which are electrons and second confined energy levels capable of being populated with second carriers which are holes, the quantum dots having a distribution of transition energies such that a level of the first confined energy levels and/or the second confined energy levels differs among the quantum dots (column 18 lines 15-30), and supply means (column 18 lines 41-49) for supplying carriers to the energy levels, wherein the supply means selectively inject or excite carriers of a predetermined energy into one of the energy levels of just one quantum dot to allow recombination of a predetermined number of carriers in said quantum dot to emit at least one photon. *Stintz* does not teach selectively injecting one energy level of just one quantum dot. *Santori* teaches in the abstract a quantum dot turnstile device that injects a

single quantum dot to emit a pair of photons. It would have been obvious to one of ordinary skill in the art at the time of the invention to selectively inject one energy level of just one quantum dot in *Stintz*, as taught by *Santori*, to emit single or pairs of photons at different of different energies for use in various communication devices, such as quantum cryptography.

Response to Arguments

Applicant's arguments with respect to claims 1-4, 17-35, 56-58, and 60-65 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Davienne Monbleau whose telephone number is 571-272-1945. The examiner can normally be reached on Mon-Fri 9:00 am to 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Dave Porta can be reached on 571-272-2444. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Davienne Monbleau

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